

# October 1998 Highlights of the Pulsed Power Inertial Confinement Fusion Program

In October, for the first time, we imploded capsules filled with  $D_2$  or  $H_2$  embedded in dynamic hohlraums. We had a total of 12 shots on Z: 5 shots with  $D_2$ - or  $H_2$ -filled capsules, 3 LANL weapon physics shots, 2 flux compression shots, a high-current-density short circuit shot to assess the performance of future machines, and a power flow shot to benchmark Z before continuing the capsule experiments.

We have begun to evaluate the requirements of a replacement machine for Z, called ZX, which would have roughly twice the current. ZX, a less ambitious facility than the proposed high yield X-1, would allow technical advances begun on Z in weapon science and ICF to continue at higher energy and power. The facility would be designed to reach 7 MJ of x-ray energy in a small z-pinch-driven hohlraum configuration, whereas Z produces 1.2 MJ in such a configuration. Hydrodynamic simulations suggest that 12-16 MJ are required for high yield.

Z delivers 60 TW of electrical power to the vacuum insulator stack in a 20-MA, 100-ns-risetime pulse. We conducted Z experiments to test a new resistive wall loss model at ZX and X-1 relevant current densities (up to 10 MA/cm). The load was a 6-mm-diameter short circuit (Fig. 1); the B-dot current monitors are accurate to 2-6%. The results indicate that the new model is correct to within 10%; our previous loss model, developed in a 1994 Jupiter design study, is off by an order of magnitude. In a separate set of experiments using 1/4 of Z without magnetically insulated transmission lines, we found that the stack operates successfully at a voltage 40% higher than predicted by Charlie Martin's insulator flashover model--the standard model used in pulsed power insulator design. The importance of this result is that the proposed ZX will be 25% more energy efficient than originally expected.

In the dynamic hohlraum ICF concept, the magnetic field generated by the high current in Z accelerates the tungsten plasma. When the tungsten strikes the CH foam cylinder, a radiation wave is generated that implodes a fuel-filled capsule embedded in the foam (see Fig. 2a). In a series of dynamic hohlraum shots in August, we achieved a record 180-eV hohlraum temperature for driving ICF capsules. Now, in five shots this month, we are assessing the capability of the hohlraum to implode a  $H_2$ - or  $D_2$ -filled capsule and our ability to fabricate and diagnose the targets. The targets were designed on LASNEX (see June 1998 *Highlights*). Time-resolved, end-on x-ray images from Shot 323 show the initial 1.6-mm-diameter capsule in absorption and, at a later time, emission from the imploded capsule before the tungsten plasma stagnates on axis (Fig. 2b).

LANL weapon physics shots are continuing at a rate of two per month. Each shot produces a wealth of data. In reality, each one represents 10-12 simultaneous experiments using an identical z-pinch source because the large x-ray energy, power, and spatial scale of the pulsed-power-driven hohlraum permits numerous diagnostics (Fig. 3). The diagnostics that view conditions inside the hohlraum include two fiber optic laser-shock-breakout diagnostics, an open beam laser-shock-breakout diagnostic, two soft x-ray filtered pinhole cameras, two silicon diode arrays, XRDs and bolometers that view the backwall, a large format pinhole camera that views the hohlraum back wall, and an active shock breakout diagnostic on the side of a tube attached to the hohlraum.

Contact: Jeff Quintenz, Inertial Confinement Fusion Program, Dept. 9502, 505-845-7245, fax: 505-845-7464, email: jpquint@sandia.gov.  
*Highlights* are prepared by Mary Ann Sweeney, Dept. 9502, 505-845-7307, fax: 505-845-7890, email: masween@sandia.gov.  
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